



Ames Research Center  
Dryden Flight Research Facility

# NASA Ames-Dryden Integrated Test Facility

## Presented at: The Control Center Technology Conference

By:

Larry Schilling, NASA  
Dave Bolen, CSC

June 18-20, 1991

N92-12014  
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## Presentation Outline

- Dryden Overview
- Integrated Test Facility
  - Concept
  - Philosophy
  - Capability

L. Schilling

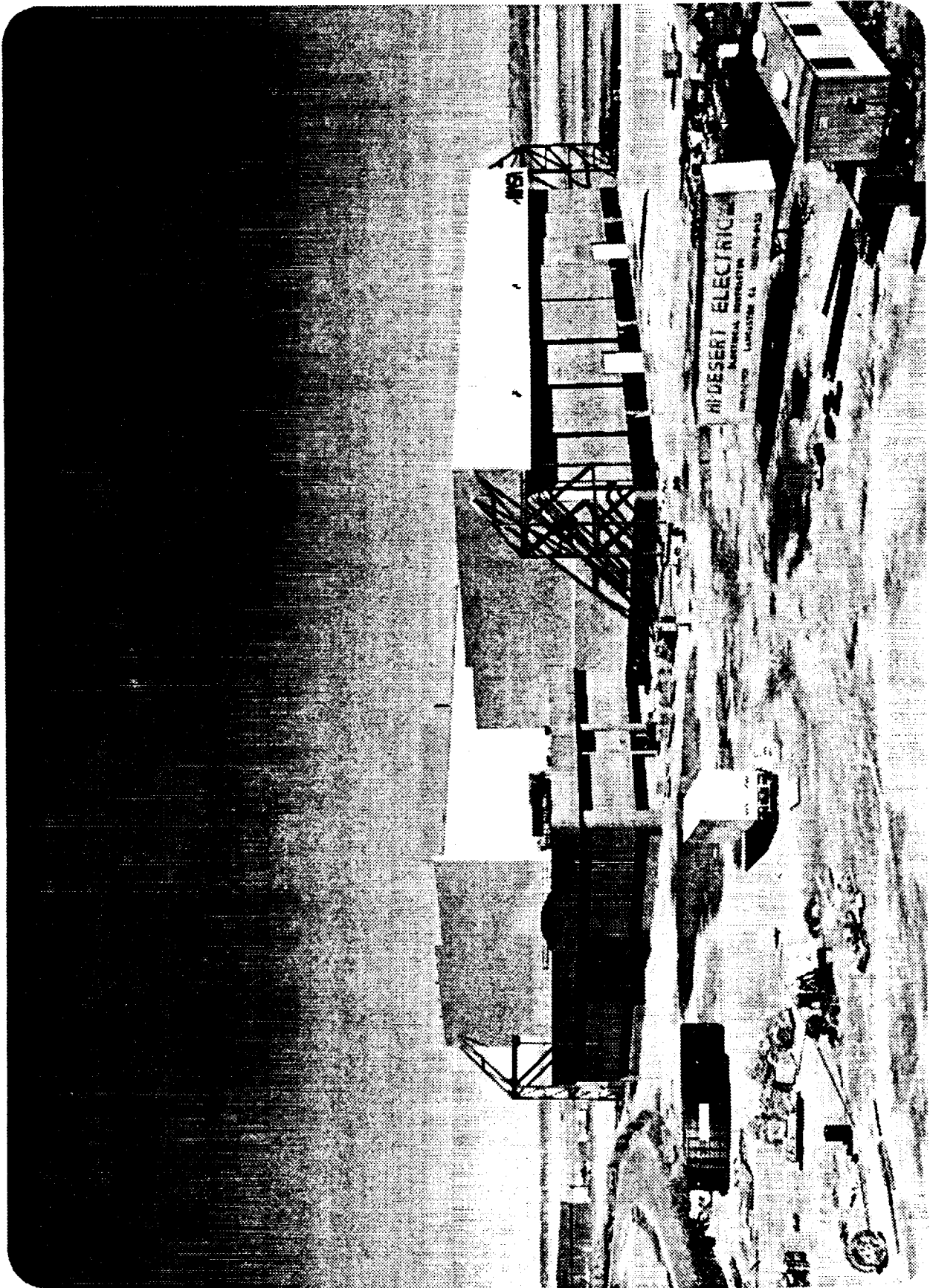
- ITF System Architecture
  - Hardware
  - Software
- Computer Aided System Testing
- ITF System Video
- Concluding Remarks

D. Bolen

# NASA Dryden Integrated Test Facility (ITF)

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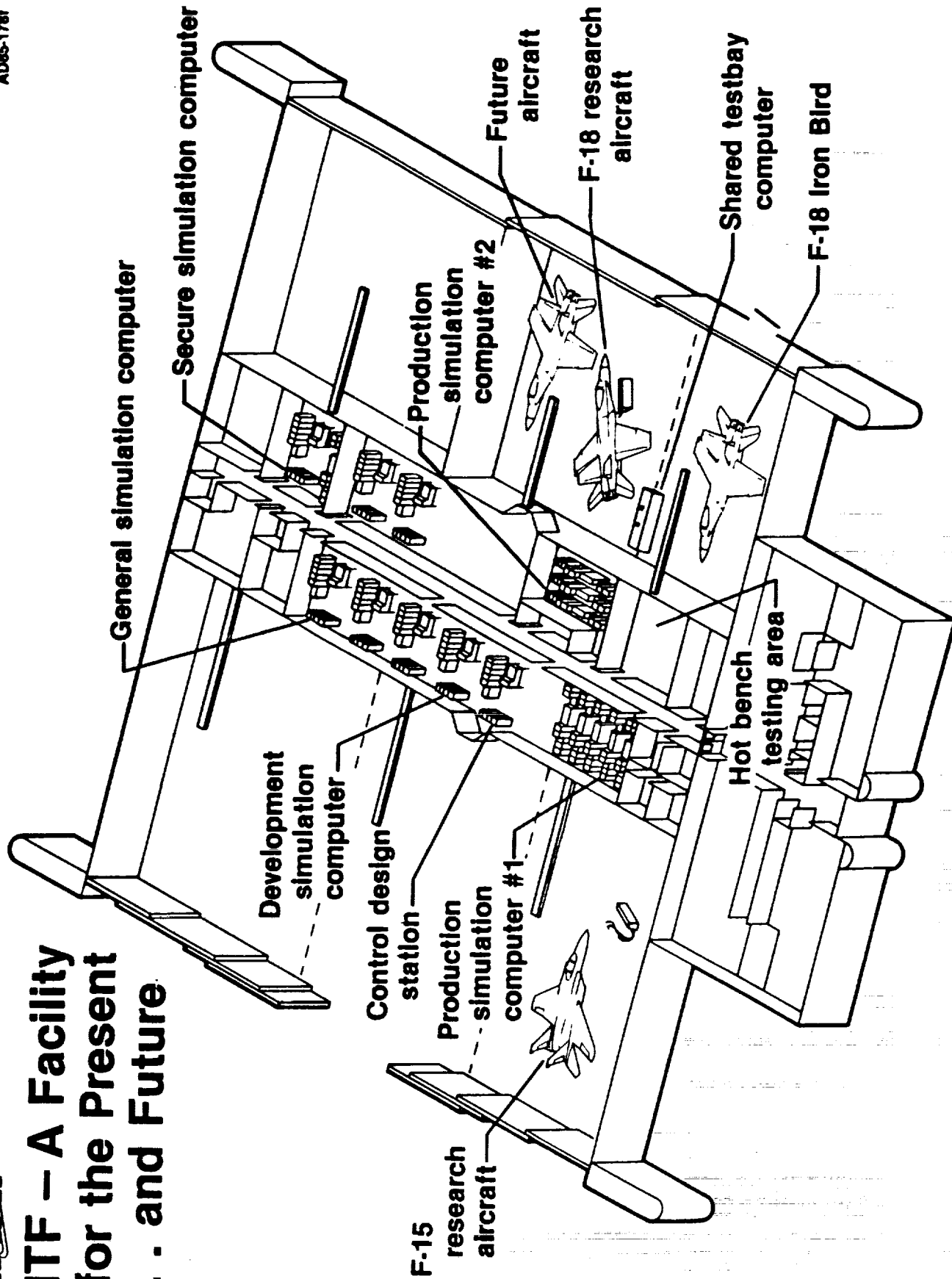
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NASA  
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# ITF - A Facility for the Present .. and Future

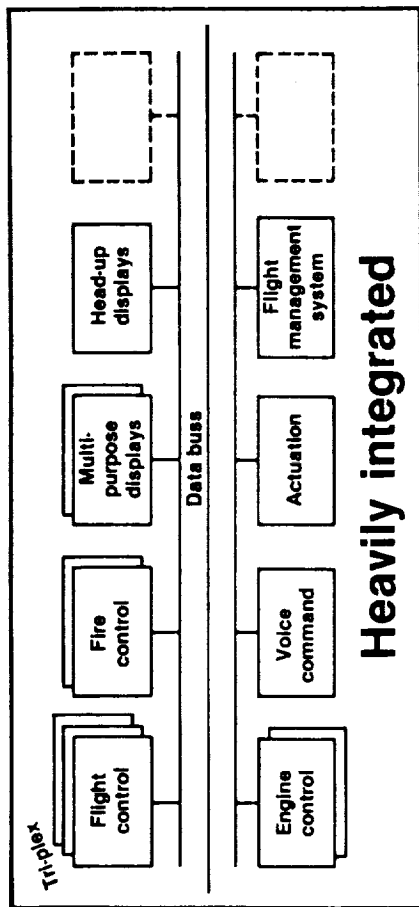


# Now and the Future

## Military and Civil Aircraft

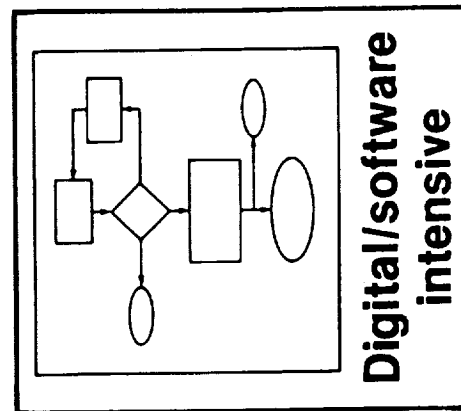


### Aircraft systems

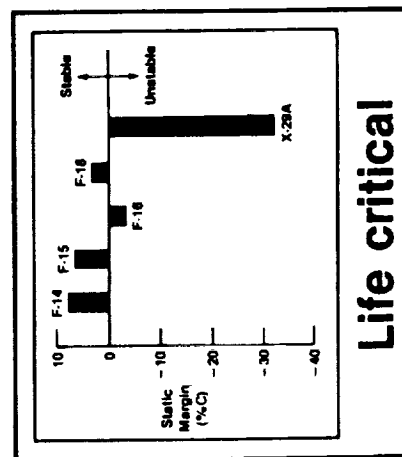


### Facility requirements

- Test entire aircraft
- Assess system interactions
- “See” into avionics systems
- Handle software intensive systems



### Digital/software intensive

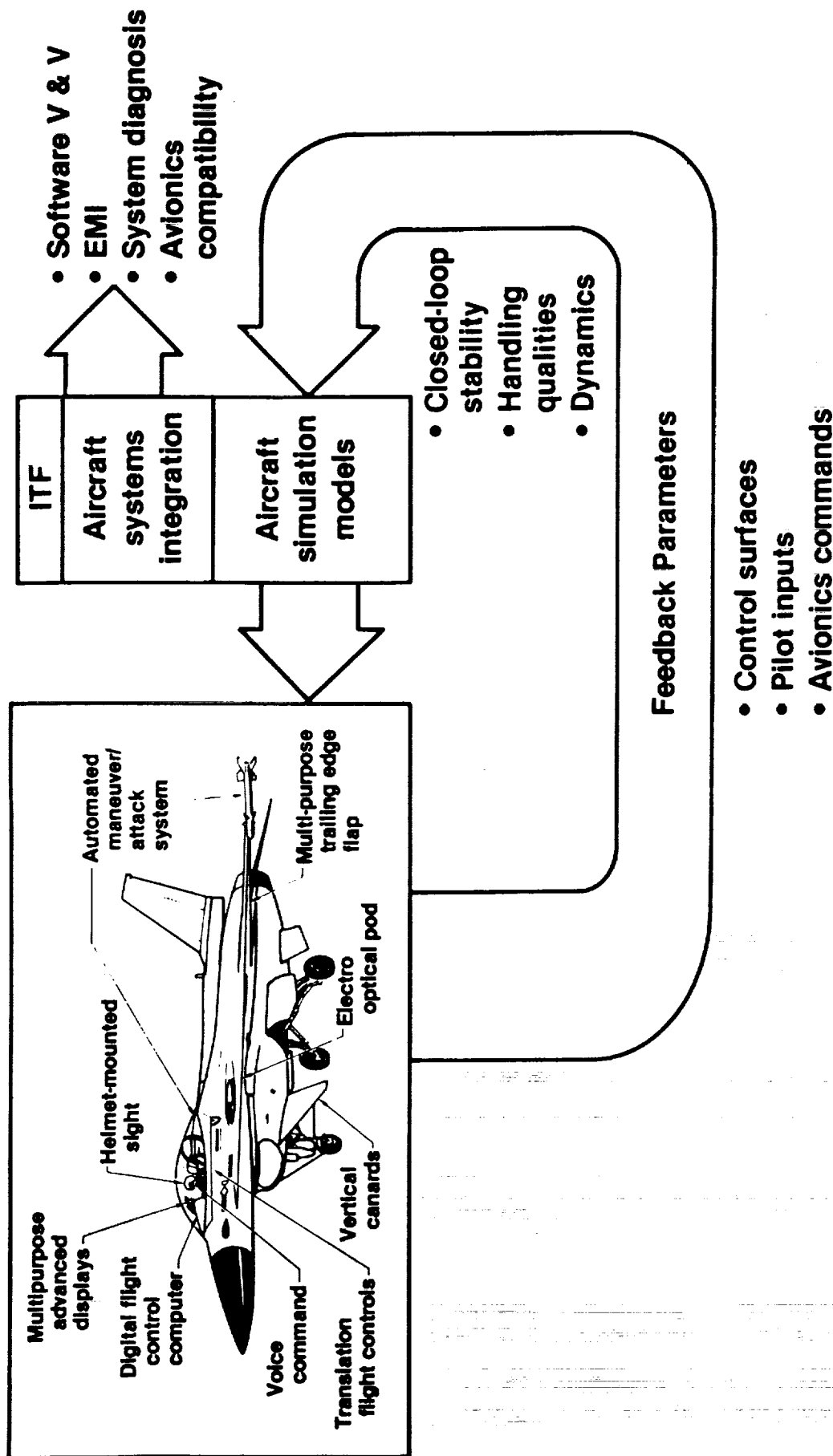


### Life critical

# Capability Concept

## Fully Integrated Testing of the Aircraft Performed Within the Facility

NASA  
DFRFB3-705a



## The ITF Philosophy

- Routinely interface actual flight vehicles.
- Make the aircraft undergoing test think it's flying.
  - Test the vehicle as a whole
  - Provide power, cooling, hydraulics
  - Tie dynamic simulation with vehicle
- Record everything.
  - Anomalies are difficult to repeat
- Make the user productive.
  - Automate testing
  - Provide quick turn-around
  - Common look and feel across projects
- Conduct tests safely
  - Personnel and equipment
- Develop ITF systems independent of building construction
  - Use a target project (F-18 HARV) to focus developments
  - Combine developers and users on one team
  - Provide generic capability for multiple projects

1. The first part of the document is a list of names and addresses of the members of the committee. The names are listed in alphabetical order, and the addresses are given in full. The list is as follows:

Name	Address
Mr. A. B. C.	123 Main St., New York, N.Y.
Mr. D. E. F.	456 Elm St., New York, N.Y.
Mr. G. H. I.	789 Broadway, New York, N.Y.
Mr. J. K. L.	1010 Fifth Ave., New York, N.Y.
Mr. M. N. O.	1111 Third St., New York, N.Y.
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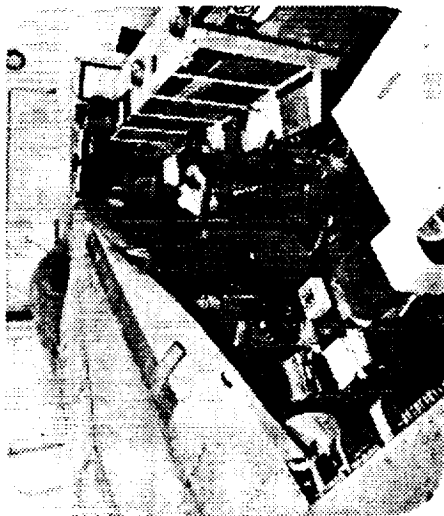
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# Major ITF Capabilities

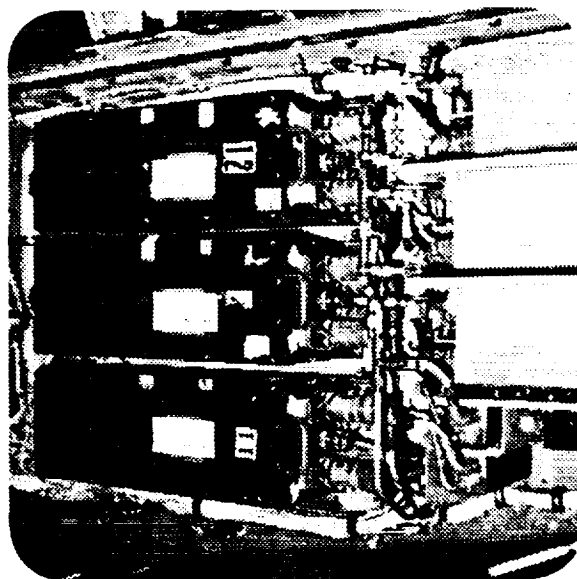
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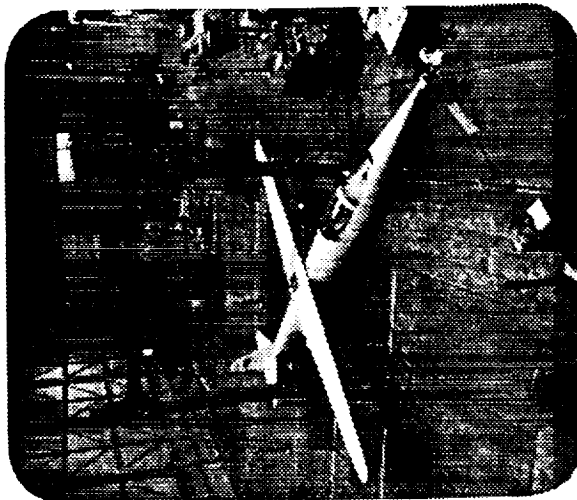
"Airplane-in-the-loop" test



Piloted simulation



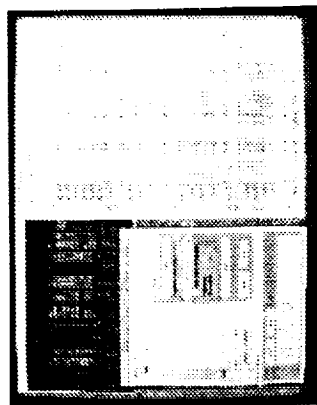
Hardware-in-the-loop and  
hot-bench tests



Ground vibration test



Remotely piloted  
vehicle control



Computer-aided  
system testing

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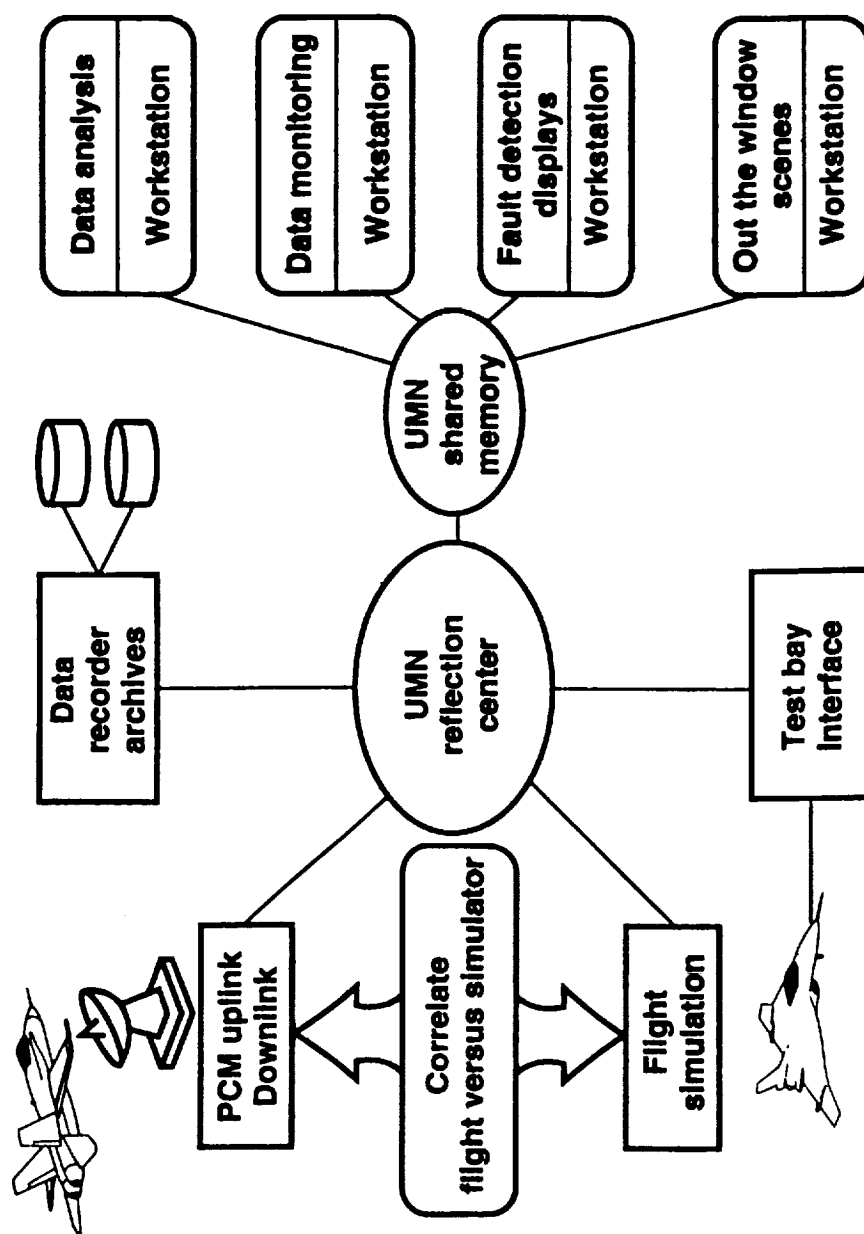
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## Architecture Details

- ITF System Architecture
  - Hardware
  - Software
- Computer Aided System Testing
- ITF Video
- Concluding Remarks

D. Bolen

# ITF System Architecture



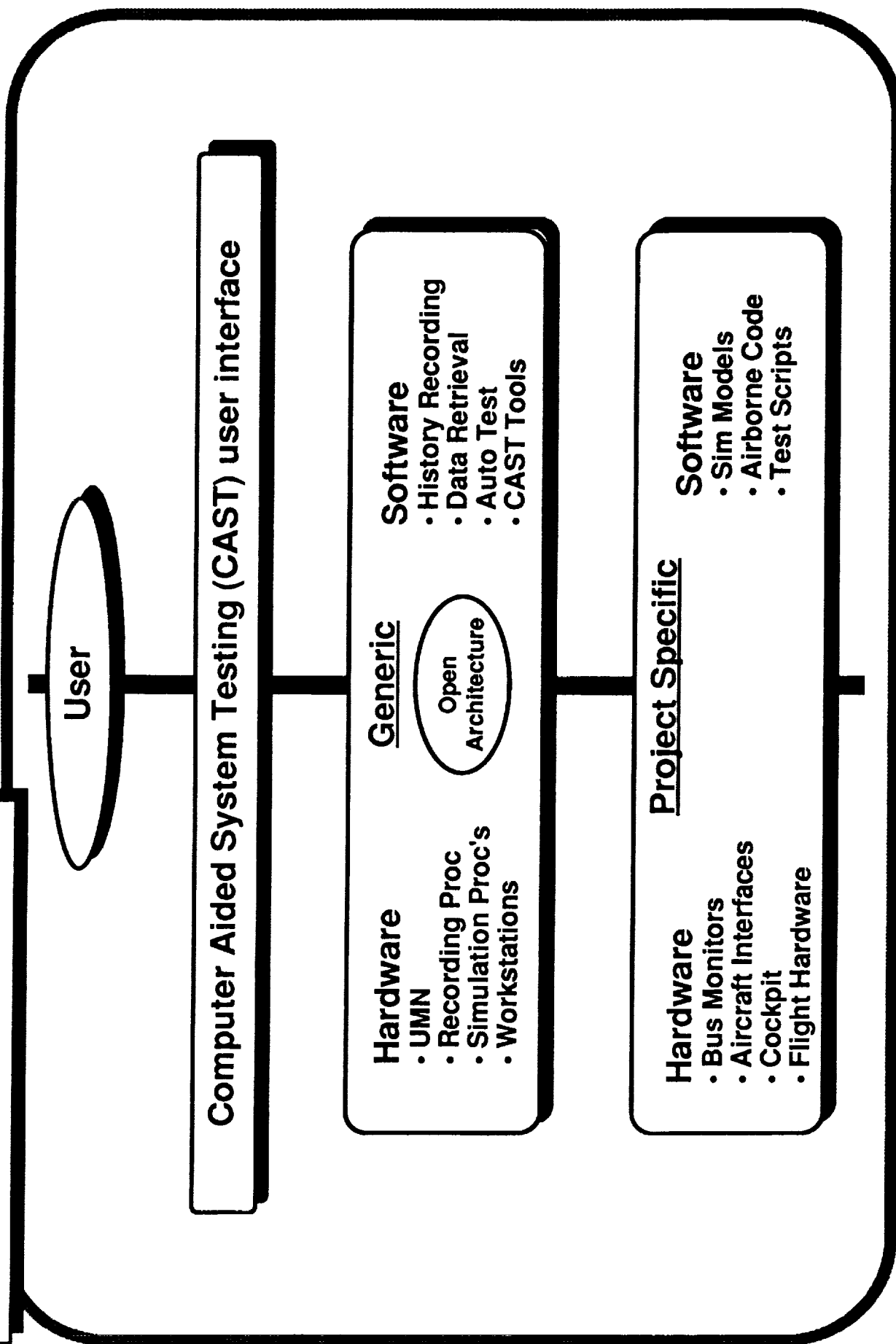
## Key elements

- **Simulation processor**
- **Test bay computer**
- **Data recording computer**
- **Workstation connectivity**
- **Universal Memory Network**
- **Realtime correlation of aircraft response to simulation**



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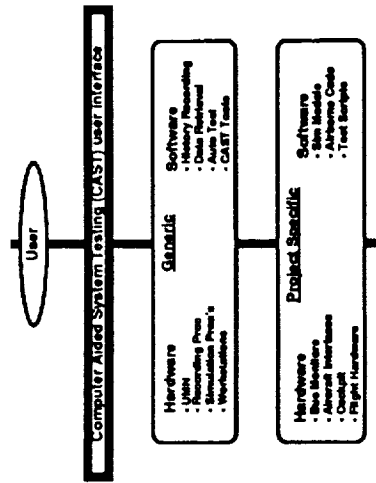
# ITF System Components



# Computer Aided System Testing

## What is CAST?

"An integrated toolset to increase the efficiency of software validation and verification."



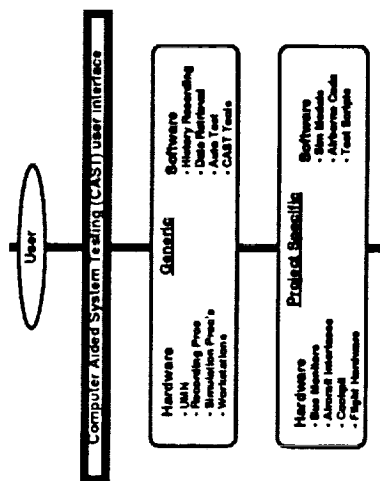
- Development effort came after Government & Industry reviews
  - JSC Software Production Facility. Real-time Display System (RTDS) now in use at Dryden.
  - KSC Launch Processing System & GOAL.
  - GD open loop testing techniques (F-111, F-16, A-12).
  - RI closed & open loop testing of X-31.
- Chose OPEN Systems architecture
  - C, Unix, X-Windows
  - High performance workstations
  - Generic to support multiple projects



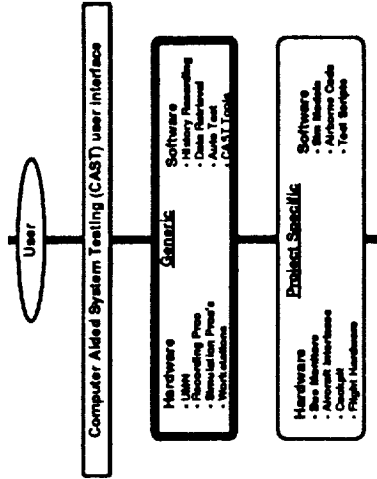
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## The CAST Package

- Eight interactive core applications.
  - XCapture
  - XLRC
  - XAnalysis
  - XGetLRC
  - XPlot
  - Xmonitor
  - XAIDS
  - XArchive
- Based on X-Windows and Dryden's GUI toolkit.
- Controls project specific applications via UMN toolkit.
  - Overall test control
  - Sim data recording and monitoring
  - 1553 data recording and monitoring
- Common look and feel across the facility.
- Designed with automation in mind.



## Generic Elements



## Hardware

- **Universal Memory Network**
  - Shared Memory for Dissimilar Computers
  - Low Latency Transfers
  - High Bandwidth (40MB/sec)
  - No Host Protocol or Overhead
- **Dedicated Recording Processor**
  - Three 850 MByte Drives
  - IRIG-B Time Source
- **Open Systems Architecture**
  - Sun, Encore, Silicon Graphics, IBM, Concurrent

## Software

- **Local Recording Capability**
  - Multiple asynchronous data streams
  - All Time Tagged data (IRIG-B - microsecond resolution)
  - Rates up to 570K words/sec
- **Standardized Data Retrieval**
  - Time History Output Files
  - Merging, Skewing, Derived Data
- **Automated Test Programs**
  - Scripts, Autotest Functions
- **Computer Aided System Testing (CAST) Tools**
  - Control, Display, Monitoring, Analysis and Retrieval software

# Overview of Test Operations

## Pretest

- Script generation
- An automated way of performing a test on the simulation processor

```
ERT
IC
H=15000.
AMCH=.5
IC:H=15000;AMCH=.5
LS
4=1
SI
PITCH=1;ROLL=0;YAW=0
POUBLET=1;ROUBLET=1;YDOUBLET=1
PSQUARE=1;XSQUARE=1;YSQUARE=1
PT1=1;RT1=1;YT1=1.
PT2=2;RT2=2;YT2=2.
PT3=3;RT3=3;YT3=3.
PA1=1;RA1=1;YA1=25.
PA2=1;RA2=1;YA2=25.
TST
RURST=1
TSHLD(76)=10
IDSVAL(76)=0
IDSVAL(332)=1
TSTIDS(76)=1
TSTIDS(332)=1
TSTIDS(42)=1;IDSVAL(42)=1
TSTIDS(1)=1;IDSVAL(1)=1;IDSVAL(1)=0
CON:N
DUMP
ALL:DUMP
OP
REFRESH
RST
```

## Real time

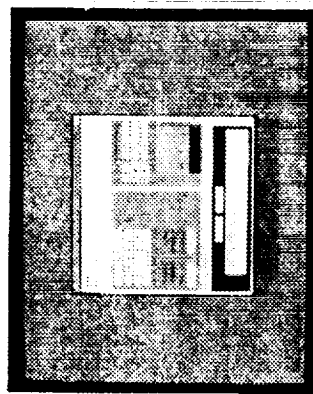
### Simulator activation

- Starts simulator
- Runs script
- Performs test



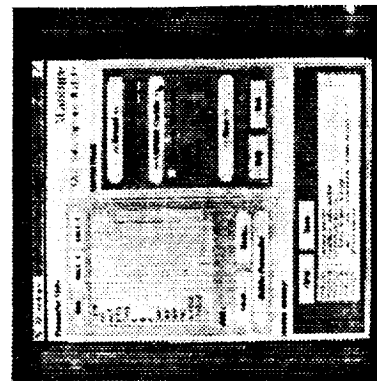
### XLRC activation

- Controls high capacity history recording



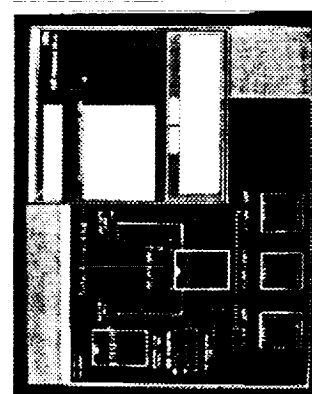
## XCapture

- Simpler data recording utility



## XMonitoring

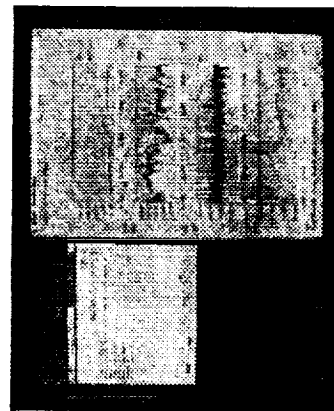
- Data monitoring



## Posttest

### XPlot

- Provides time history and frequency response plots



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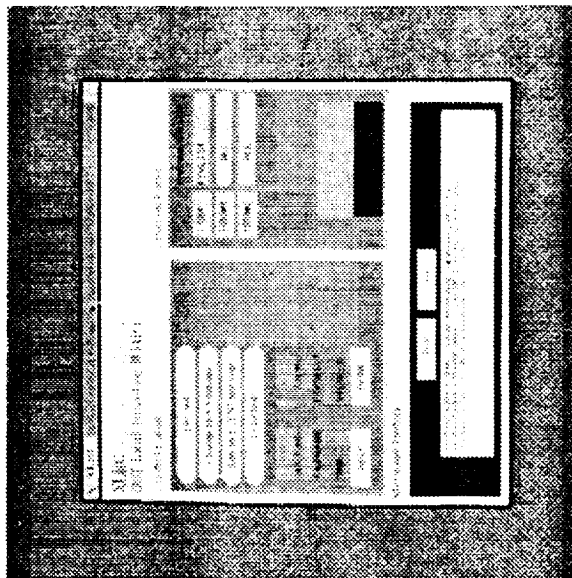


# XLRC Description

## CAST Local Recording Capability Utility

**NASA**  
D91-148

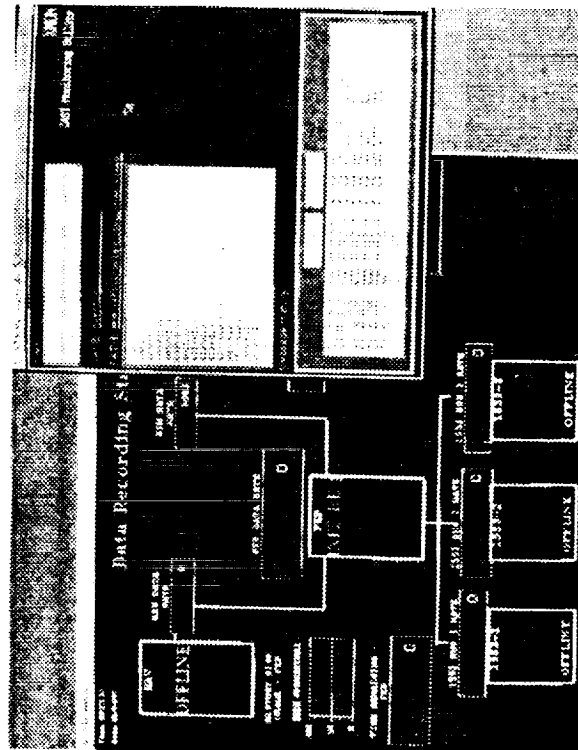
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- Provides controls for the high capacity history recording process
- X-window interface from a workstation
- Builds history files
- Records all data time tagged

# 

NASA  
D91-149

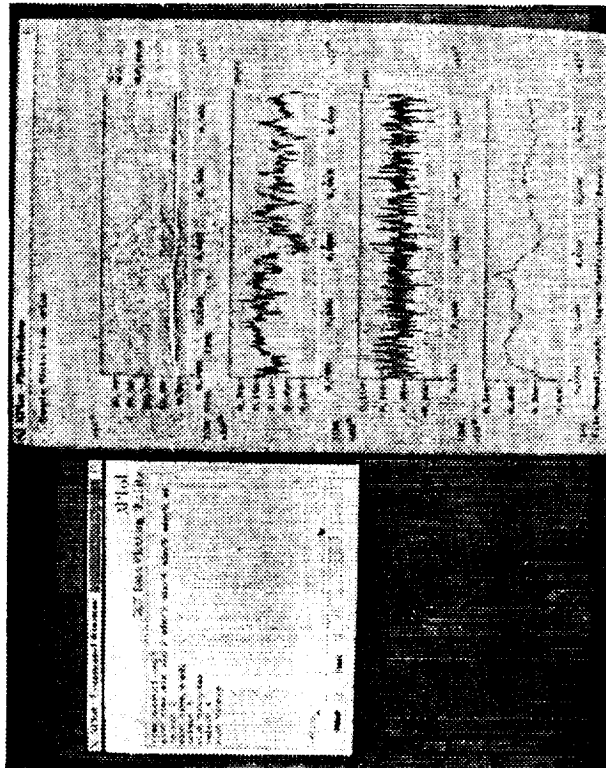


- Provides user definable and selectable display outputs
- X-window interface from a workstation
- Integrated with DataViews™ to provide a multitude of graph and plot types
- Provides realtime displays from the memory network current value tables
  - SIM and 1553 bus data
- Display change in less than 1 second

# XPlot Description

## CAST Data Plotting Utility

**NASA**  
D91-150



- Utility for plotting XY data
- Provide time history and frequency response plots
- X-window interface from a workstation
- Accepts standard GETDATA (Dryden common) file formats (UNC3, CMP3, ASC1)
- Generates research report compatible output



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## Other CAST Tools

### **XCAPTURE**

- Limited realtime data capture on a workstation

### **XANALYSIS**

- Runs analysis applications on data collected

### **XARCHIVE**

- Archives network files (compressed, encrypted, etc..)

### **XAIDS**

- Aircraft Interrogation & Display System
- User-definable displays

### **XGETLRC**

- Retrieves history data
- Thins data as required
- Generates multiple output formats (ASCII, Binary, etc.)

### **Auto Test Programs**

- Automate all CAST tools



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## ITF System Video

- **5 Minute video of how the CAST tools are used in the ITF.**
  - sim cockpit and scripts
  - aircraft in test
  - CAST tools in use
- **This test took 1 hour versus 1 day without the ITF System.**
- **Parallel test functions are shown serially on the video.**



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## Concluding Remarks

- Systems built around an OPEN architecture.  
(Vendor independence, modularity, portability, connectivity)
- Provides a common "look and feel" to the user.
- Provides the ability to interface to DISSIMILAR systems in REAL-TIME.
- Portable to other facilities.
  - Dryden flight control rooms
  - National Aerospace Plane contractors chose Dryden approach as their standard for data collection and reduction.
- Expandable to FUTURE flight research programs.
  - Interface of generic system requires ~ 1/2 workyear.



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## Concluding Remarks (cont)

"Highly interactive systems => measured productivity improvements"

- Measured productivity improvements:

	<u>BEFORE</u>	<u>NOW</u>
X-29 Frequency Response Tests	8 hours	2 hours
X-29 End to End System Test	8 Weeks	3 Weeks
F-18 SIM Check Cases	2 1/2 Days	4 Hours

- Our estimate: Overall test time reduced by a factor of 3

**SIZE** \_\_\_\_\_ **INTENTIONAL BRAND**